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PROGRESS REPORT

TO

OCTOBER 31, 1956

ON

TASK ORDER "C"

PROJECT NO. 1783

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A. Transmitter

Methods of transmitting audio power directly into the 60 cycle power line were first considered. The impedance of the line generator at 60 cps was found to be in the neighborhood of 0.1 ohm. An effort was made to match the output impedance of the audio transmitter to this impedance. There resulted the design and breadboarding of several different transmitter circuits. The principle in each of these was to null the 60 cps line voltage in such a way as to prevent it from appearing at the output of the transmitter while at the same time match the transmitter output to the line. Although the effort showed promise, the approach was finally abandoned for the following reasons:

a) Design was too complex.
b) Components were too large.
c) Adjustment for balancing out the 60 cps voltage was too critical.
d) Where L-C filters were considered for filtering the 60 cps voltage, inductors that could withstand the large voltages across them without saturating were not practical.

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The next approach was to "brute force" audio power into the line by impressing audio voltage on the grids of paralleled cathode followers with cathodes connected directly into the line. Four 6AS7 triodes were paralleled for this purpose. This method proved fruitful in transmitting speech voltages across the power line so that what was being sent could be understood at the receiving end. A unique arrangement was utilized for holding quiescent plate current constant with 60 cps 115 V impressed between cathode and ground of each cathode follower. However, in order to accomplish this, triode grid to cathode voltage had to be varied in such a manner as to make grid to plate voltage peaks excessive. As a result grid to plate arc over intermittently occurred in the cathode follower tubes. Triode cathode followers were replaced with 5881 beam power tubes. The constant current characteristic of the beam power tube brought grid to plate voltage variations within safe limits while making quiescent plate current independent of the 60 cps voltage applied between cathodes and ground. Due to the non linear i_b-e_c characteristic of beam power tubes intermodulation products resulted between the harmonics of 60 cps line voltage and the audio transmission voltage which distorted speech voltages beyond recognition at the receiver. To obviate this difficulty, four 5881 tubes were arranged as cathode followers in push-pull feeding the line. The more linear nature of push-pull operation resulted in eradication of intermodulation with improved intelligibility of the transmitted signal. It remains to attempt to substantially reduce the size of the transmitter which may be possible as receiver techniques are improved.

B. Receiver

The receiver used in the earlier phase of this project consisted of a high pass R-C filter network at the input with a corner at 500 cps and an asymptotic fall-off of 36 db per octave. At 1440 cps the response of this filter is 3 db down from zero db reference. Transmitting speech signals using cathode follower techniques referred to in section A, the input filter was sufficient to eliminate enough of the lower harmonics of the 60 cycle line voltage to enable threshold recognition of speech at the receiver. However, the harmonics of 60 cycles within the filter's pass band tended to obscure the received signal too close to the point of unintelligibility. By using a "notch" filter in cascade with the R-C filter, the ability to recognize what was being sent through the transmitter was greatly improved in addition to the elimination of "masking" noise due to cancellation of 60 cycle harmonics. In the "notch" filter speech signals are impressed on a revolving magnetic drum

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and picked up by two magnetic play-back heads separated along the drum's periphery by a delay of 1/60th of a second. By properly adding the two magnetically "picked up" signals, cancellation of 60 cycle harmonics is achieved without cancelling speech frequencies. Due to variations in the angular velocity of the magnetic drum, a "wow" results which makes cancellation imperfect. This difficulty in the present notch filter limits reception and methods for its elimination are being considered.

C. Conclusion

Future plans are as follows:

a) Improve the quality of the receiver.
b) Reduce the size of the transmitter, if possible.
c) Determine maximum distance of transmission under the most efficient conditions of transmission and reception.

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